FOREST PEST MANAGEMENT

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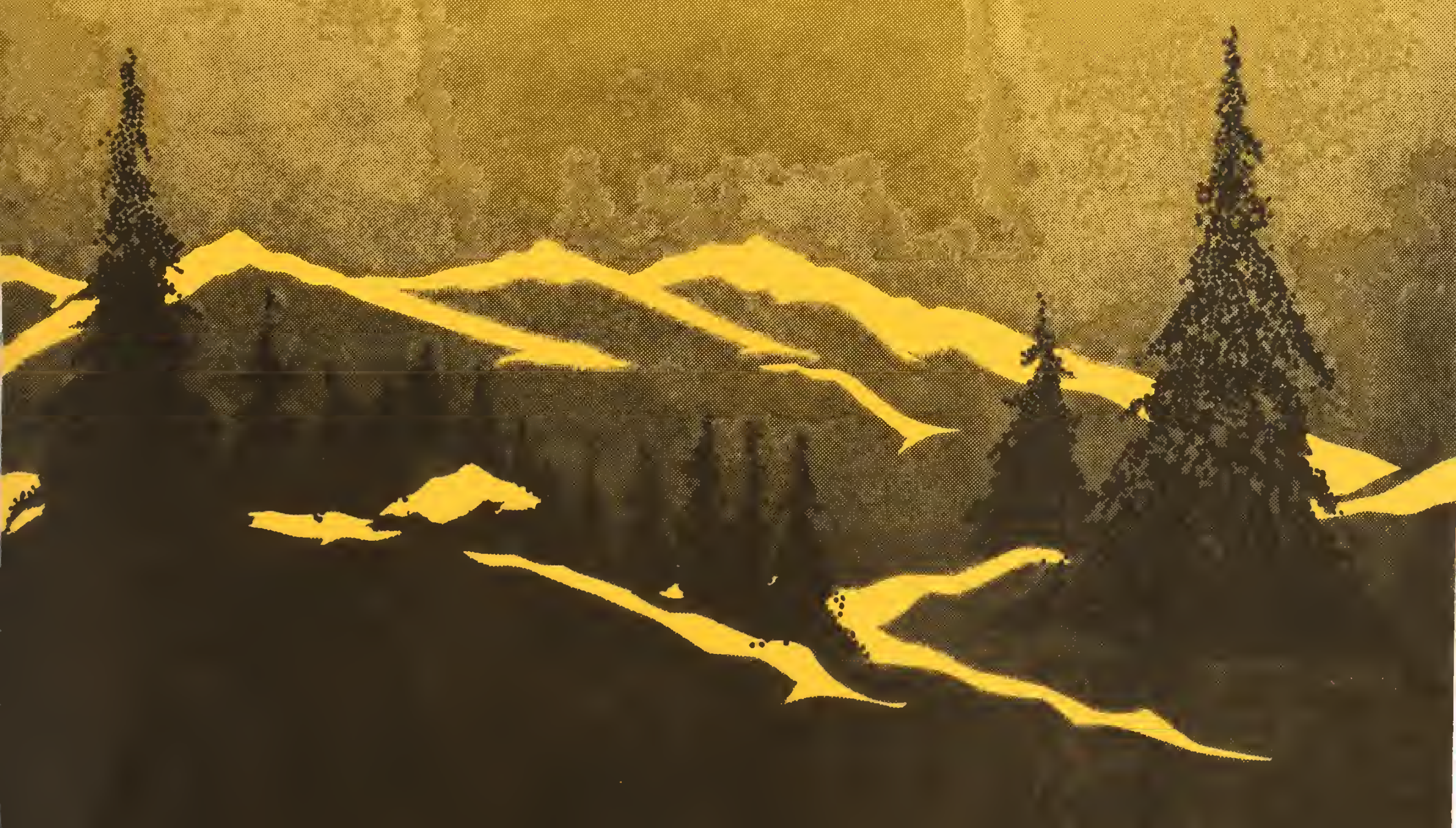

United States Department of Agriculture
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EFFECTS OF APPLICATION RATE AND TIMING OF ETHEPHON TREATMENTS ON ABSCISSION OF PONDEROSA PINE DWARF MISTLETOE

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ABSTRACT

Evaluation of field tests of the plant growth regulator, ethephon, has shown that significant abscission of dwarf mistletoe shoots occurs within a few weeks after application. Tests conducted in the Black Forest north of Colorado Springs, Colorado, in 1988, on ponderosa pine dwarf mistletoe, *Arceuthobium vaginatum* ssp. *cryptopodum*, showed abscission rates of 76 to 91 percent. Applications were made in mid-June, mid-July, and mid-August at rates of 2200 and 2700 ppm of ethephon in water with a spreader-sticker.

Examination of trees yearly after treatment showed no significant differences in numbers of shoots between treatments after the second year. This trend did not change through the fifth year after treatment. However, significant differences in numbers of shoots and fruits among years within treatments were noted.

The fourth year after treatment, some development of mature shoots with fruits was observed. It is also interesting to note that 34 percent of the original branch infections died as a result of breakage, girdling by rodents, and other natural agents during this time. This phenomenon occurred both on treated and control (non-treated) trees.

INTRODUCTION

Interest in the use of the plant growth regulator ethephon (2-chloroethyl) phosphonic acid) in controlling spread of mistletoes is evidenced by many reports in the literature (see references). Ethephon causes abscission of the aerial portions of both Arceuthobium and Phoradendron species, thereby preventing spread by seed.

In the Rocky Mountain Region, tests on ponderosa pine dwarf mistletoe, Arceuthobium vaginatum ssp. cryptopodum, were begun in 1988. During June, July, and August 1988, ethephon (Chipco Florel[R] Pro Brand Plant Regulator) was applied by hydraulic sprayer at rates of 0 (control), 2200 and 2700 ppm with nonionic surfactant (Ortho X-77 spreader) in water to infected ponderosa pines in the Black Forest north of Colorado Springs, Colorado. Thirty non-systemic female infections were randomly selected in the lower crowns of pines for each treatment and application date, usually three infections per tree. The number of shoots and shoots with fruits on each infection was determined and recorded prior to treatment and each year thereafter. Details of the study and subsequent yearly observations are contained in the reports by Johnson and Hildebrand, 1989b; Johnson, Hildebrand and Hawksworth, 1989; Johnson and Hildebrand, 1990; Johnson, 1991; and Johnson, 1992. This report summarizes data collected since the inception of the study in 1988.

METHODS AND MATERIALS

Direct observations of previously tagged infections on branches were made in July each year. If branches or infections had died since the last observation, this was noted. The presence of shoots and those with fruits was recorded. Results for the two application rates (2200 and 2700 ppm ethephon) were compared to the controls and to each other using one-way analysis of variance (ANOVA) and contrast tests. In addition, multiple comparison tests were used to compare the changes in numbers of shoots and fruits among years within each treatment and within the control[1,2].

1/ Mize, C. W. and R. C. Schultz. 1985. Comparing treatment means correctly and appropriately. Can. J. For. Res. 15:1142-1148.

2/ Norusis, M. J./SPSS Inc. 1988. SPSS/PC+ V2.0 Base Manual. SPSS Inc., Chicago, Illinois. p. B152-163.

RESULTS AND DISCUSSION

Data for each application date within treatments (June, July, and August) were combined since there was little difference in results between treatment dates (Johnson and Hildebrand, 1989b). Since seed dispersal commenced by early August, treatment by mid-July was effective in causing abscission of shoots with fruits and was effective in limiting spread of the disease in the first year. Loss of infected branches to mortality caused by breakage, girdling by rodents, and other natural agents was observed since the inception of the study and amounted to 34 percent (Table 1). An adjustment of sample size was made accordingly.

Five weeks after treatment in 1988, the numbers of shoots per branch were significantly less in ethephon-treated infections compared to controls (Figure 1). There was also a significant difference between 2200 and 2700 ppm ethephon treatments, numbers of shoots per branch were 2.4 and 0.9, respectively (Table 2). Only one infection out of 270 tagged for observation had fruits. Development of small immature shoots was noted in all treatments by August of the first year.

In 1989, one year following treatment, the numbers of shoots were significantly less for ethephon-treated infections compared to controls (Table 2); however, results were not significantly different between the two ethephon application rates after the first year. A significant reduction in numbers of shoots per branch was noted in the controls between 1988 and 1989 (from 10.1 to 7.0, respectively). It is thought that natural abscission and insect activity caused the reduction in numbers of shoots observed in the controls compared to the previous year (Table 3). Differences in numbers of shoots within years for the ethephon treatments also occurred (Table 3).

In 1990 and thereafter, dwarf mistletoe shoot and fruit development was depressed uniformly over the two treatments and the controls. This may be due to drought. There were no significant differences in numbers of infections with shoots or with fruits for any treatment (Tables 2 and 4). In 1990, of a total of 215 infections observed, only three had mature shoots with fruits, and the number of individual shoots was sparse.

In 1992, mature shoots with fruits were present in all treatments (Figure 2). No significant differences were noted between treatments; however, significant differences were noted among years within treatments (Tables 4 and 5). By 1993, numbers of shoots with fruits had increased in all treatments (Table 4).

Ethephon does not appear to provide long-term control of dwarf mistletoe, but by causing shoot abscission, it can substantially reduce spread of the parasite. To our knowledge, ethephon has no systemic action and only external portions of dwarf mistletoe plants are affected. These data appear to confirm this observation. Regrowth of treated infections has resulted in the production of mature shoots and fruits the fourth year after treatment, and up to 26 percent of the infections had fruits by the fifth year.

The lower rate of application of ethephon (2200 ppm) was as effective as the higher rate (2700 ppm) the first year after treatment, thus the lower rate is recommended.

Additional applications of ethephon will be necessary to protect mistletoe-free understory pines from infection unless silvicultural treatments are used to remove infected trees. It appears that applications will be necessary every four years under the conditions noted for this species of dwarf mistletoe. The timing of re-applications may vary for other species and climatic conditions.

The most promising use of the chemical is in limited situations where high-value infected trees need to be retained for aesthetic reasons and it is desirable to prevent infection of planted trees or natural regeneration of the same species.

Ethephon is available under the trade name Florel[R] through the following distributors: Monterey Chemical, Fresno, California; and Charles H. Lilly Company, Portland, Oregon.

Table 1. Number of dwarf mistletoe infection sites remaining on live ponderosa pine branches treated with ethephon and observed over a 5-year period, Black Forest, Colorado.

Treatment	Year and Number of Live Branches Remaining 1988	1989	1990	1991	1992	1993	%
Control (0 ppm)	90	81	71	61	58	59	34
Ethephon (2200 ppm)	90	78	72	62	63	58	35
Ethephon (2700 ppm)	90	81	72	66	63	61	32
Totals	270	240	215	189	184	178	34

Table 2. Effect of ethephon treatment on numbers of dwarf mistletoe shoots per branch on ponderosa pines observed over a 5-year period, Black Forest, Colorado.

	Year						
Treatment	1988[1]	1988[2]	1989	1990	1991	1992	1993
Control (0 ppm)	10.6a[3]	10.1a	7.0a	0.4a	0.4a	2.4a	3.6a
Ethephon (2200 ppm)	10.0a	2.4b	4.1b	0.6a	0.5a	2.9a	4.4a
Ethephon (2700 ppm)	9.3a	0.9c	2.6b	0.5a	0.3a	2.3a	4.0a

1/ = before treatment
2/ = 5 weeks after treatment
3/ = means in a column followed by the same letter are not significantly different according to oneway ANOVA and contrast analysis tests at P=0.05

Table 3. Changes among years in numbers of dwarf mistletoe shoots per branch on ponderosa pines observed over a 5-year period, Black Forest, Colorado[1].

Treatment	Year					
Control	1990	1991	1992	1993	1989	1988
(0 ppm)	0.4	0.4	2.4	3.6	7.0	10.1
Ethephon	1991	1990	1988	1992	1989	1993
(2200 ppm)	0.5	0.6	2.4	2.9	4.1	4.4
Ethephon	1991	1990	1988	1992	1989	1993
(2700 ppm)	0.3	0.5	0.9	2.3	2.6	4.0

1/ = any means underscored by the same line are not significantly different according to Scheffe's multiple range test at P=0.05

Table 4. Effect of ethephon treatment on numbers of dwarf mistletoe shoots with fruits per branch on ponderosa pines observed over a 5-year period, Black Forest, Colorado.

Treatment	Year 1989	1990	1991	1992	1993
Control (0 ppm)	2.09a[1]	0.00a	0.00a	0.02a	0.32a
Ethephon (2200 ppm)	0.10b	0.01a	0.08a	0.35a	0.90a
Ethephon (2700 ppm)	0.01b	0.03a	0.02a	0.37a	1.64a

1/ = means in a column followed by the same letter are not significantly different according to oneway ANOVA and contrast analysis tests at P=0.05

Table 5. Changes among years in numbers of dwarf mistletoe shoots with fruits per branch on ponderosa pines observed over a 5-year period, Black Forest, Colorado[1].

Treatment	Year				
Control	1990	1991	1992	1993	1989
(0 ppm)	0.00	0.00	0.02	0.32	2.09
Ethephon	1990	1991	1989	1992	1993
(2200 ppm)	0.01	0.08	0.10	0.35	0.90
Ethephon	1989	1991	1990	1992	1993
(2700 ppm)	0.01	0.02	0.03	0.37	1.64

1/ = any means underscored by the same line are not significantly different according to Scheffe's multiple range test at P=0.05

PESTICIDE DISCLAIMER

Figure 1 DWARF MISTLETOE INFECTIONS WITH SHOOTS BEFORE AND AFTER ETHEPHON TREATMENT

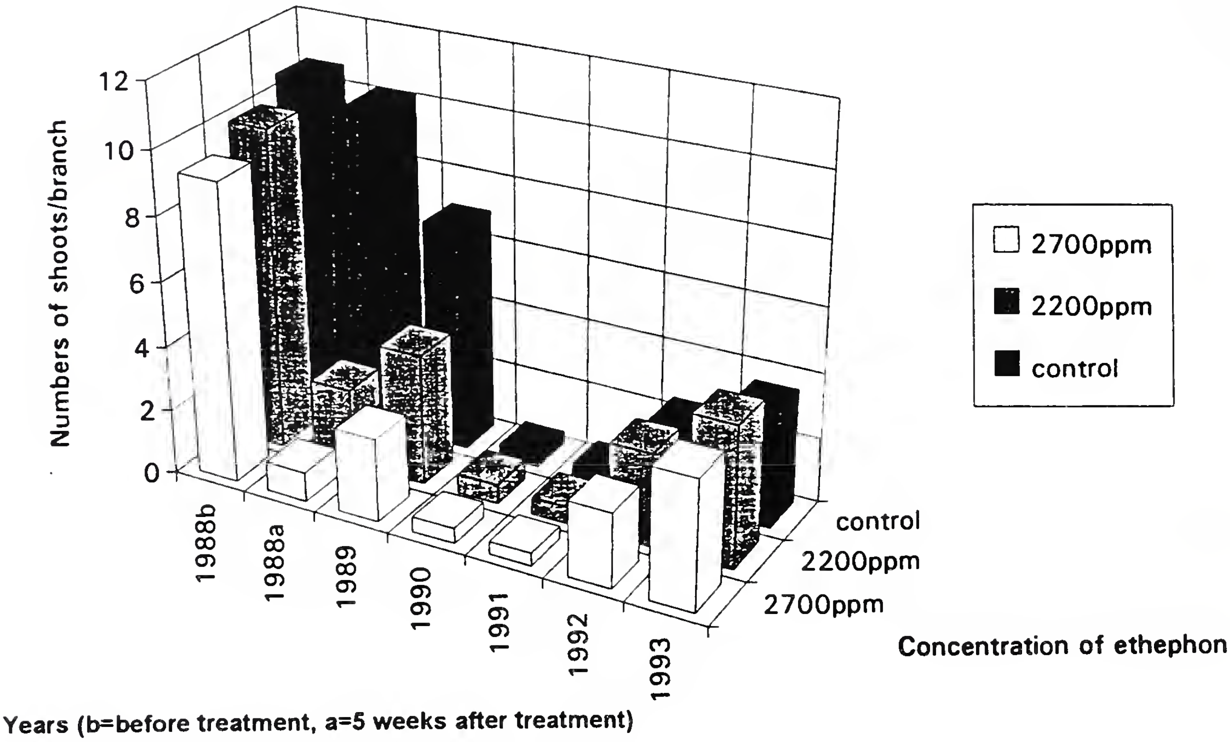
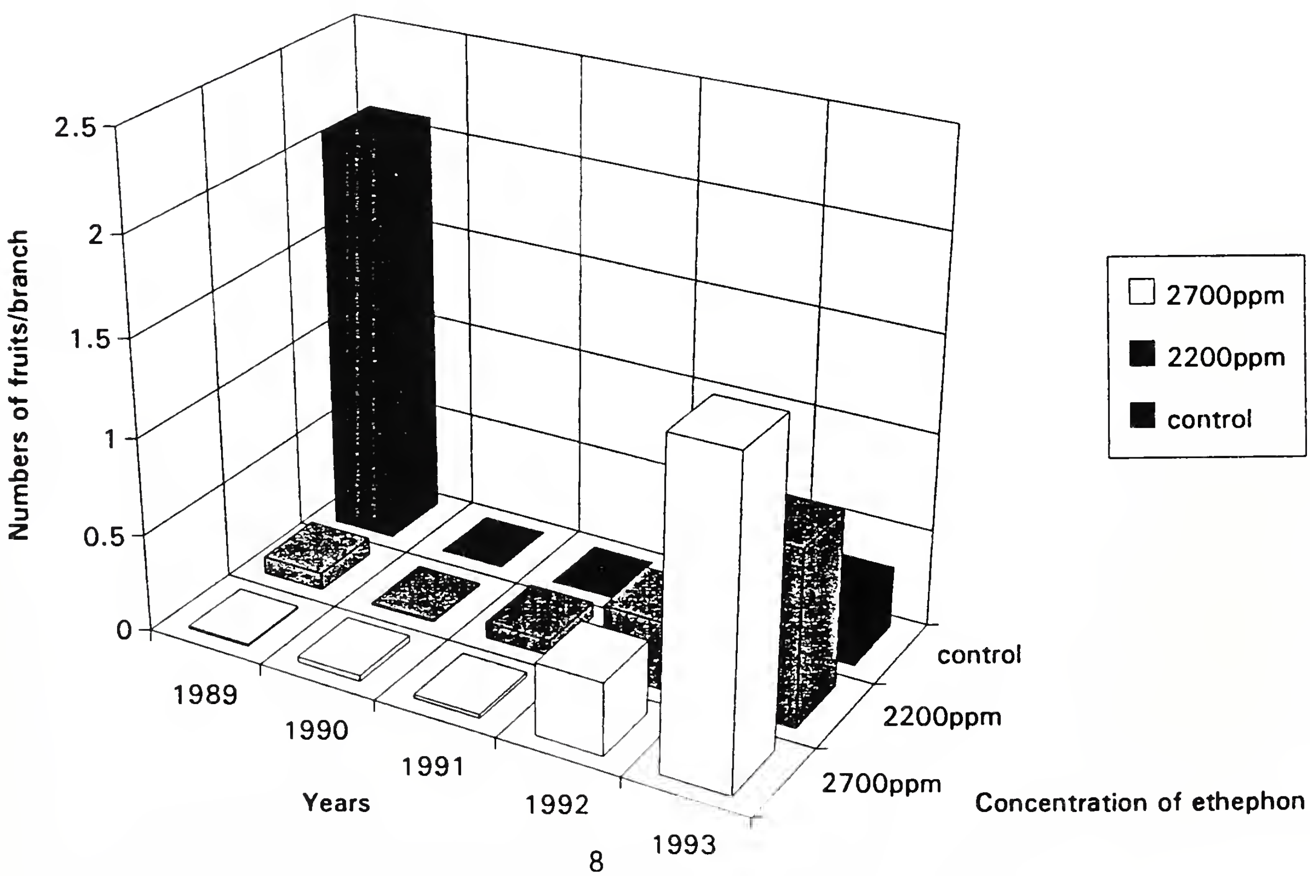


Figure 2 DWARF MISTLETOE INFECTIONS WITH FRUITS AFTER ETHEPHON TREATMENT



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